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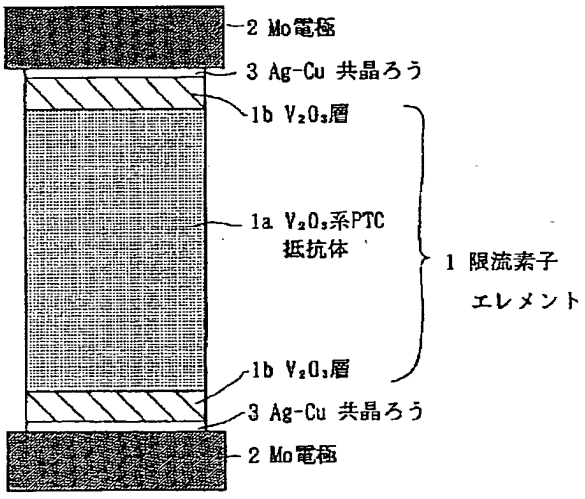
(54)【発明の名称】　限流素子

(57)【要約】
【課題】酸化バナジウム系セラミックスからなる限流素子の転移時の収縮と電極の熱膨張との差による応力を緩和し、通電や熱サイクルの繰り返し時に起きる電極の剥離等を防止する。
【解決手段】$(V_{1-x}\ A_x)_2O_3$ ＰＴＣ抵抗体１ａの端面に、元素Ａを含まないV_2O_3層１ｂを０．１～２．５ｍｍの厚さに形成し、Ａｇ－Ｃｕ共晶ろう３でＭｏ電極２をろう付けする。



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【特許請求の範囲】

【請求項１】酸化バナジウム系セラミックス（$V_{1-x}A_x)_2O_3$〔Aはアルミニウム、クロム、スカンジウムまたはランタノイドから選ばれた少なくとも１種の元素で、０．００１≦ｘ≦０．３０〕からなり、正の抵抗温度特性を有するＰＴＣ抵抗体を用いた限流素子において、ＰＴＣ抵抗体と電極との接合端面に元素Ａを含まない酸化バナジウム層を有することを特徴とする限流素子。

【請求項２】元素Ａを含まない酸化バナジウム層の厚さが、０．１～２．５ｍｍの範囲にあることを特徴とする請求項１記載の限流素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、正の抵抗温度係数を持つ酸化バナジウム系〔$(V_{1-x}A_x)_2O_3$ Aはアルミニウム、クロム、スカンジウムまたはランタノイドから選ばれた少なくとも１種の元素〕ＰＴＣ抵抗体（以下V_2O_3系ＰＴＣ抵抗体と略す）を用いる限流素子に係り、特に長期にわたる信頼性に優れる限流素子に関する。

【０００２】

【従来の技術】近年、低圧配電系統においても大容量化が進展し、それに伴い負荷が短絡した際に流れる過電流も大電流化しており、ブレーカについても高遮断容量化が望まれている。このような技術動向に対応して、大電流、大電力用の過電流保護素子として酸化バナジウム系セラミックスを主成分とするV_2O_3系ＰＴＣ抵抗体を用いる限流素子の利用が期待されている。

【０００３】V_2O_3系ＰＴＣ抵抗体は１００℃～２００℃の間で金属から絶縁物に転移する性質（Ｍ－Ｉ転移）を有しており、室温付近では比抵抗が10^{-3}Ω・ｃｍと小さいが、室温から１００℃～１５０℃にかけてゆるやかに増加し、１５０℃付近で２桁程度急激に増大し（この急増する温度を転移温度と称する）、１５０℃～２００℃においてピークとなり，それ以上の温度では低下する性質を有する。

【０００４】このような性質を有するV_2O_3系ＰＴＣ抵抗体は過電流が流れた際のジュール熱により温度が上昇し，抵抗値が増大することを利用して、その抵抗増大により過電流を限流することができる。そのため、これに電極を接合して限流素子として用いられる。

【０００５】

【発明が解決しようとする課題】V_2O_3系ＰＴＣ抵抗体のＰＴＣ現象は、転移時のバンド構造の変化により比抵抗が急増するものである。そしてこのバンド構造の変化に伴い、ｃ軸が０．６％収縮するのに対して、ａ軸は１．０％膨張するため、V_2O_3系ＰＴＣ抵抗体の熱膨張係数は、Ｍ－Ｉ転移時に負の膨張を示すという非直線的な変化となっている。その様子を図２に示す。縦軸は

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熱膨張率（ｄＬ／Ｌ）、横軸は温度である。

【０００６】限流素子とする際に接合する電極材料としては、熱膨張係数が似ているモリブデンや銅等が用いられる。しかし、これらの金属の熱膨張は、ほぼ直線的であるため、ＰＴＣ抵抗体の転移時に熱膨張係数が大きく異なってしまい、電極接合面に大きな応力がかかって電極の変形や、甚だしい場合には電極の剥離を引き起こすことがある。

【０００７】本発明は上述の問題点を解決するためになされ，その目的はV_2O_3系ＰＴＣ抵抗体を用いた限流素子における熱膨張係数差による応力を緩和し、電極の剥離等を防止して、長期信頼性に優れる限流素子を提供することにある。

【０００８】

【課題を解決するための手段】上記課題解決のため本発明は、バナジウム系セラミックス（$V_{1-x}A_x)_2O_3$〔Aはアルミニウム、クロム、スカンジウムまたはランタノイドから選ばれた少なくとも１種の元素で、０．００１≦ｘ≦０．３０〕からなり、正の抵抗温度特性を有するＰＴＣ抵抗体を用いた限流素子において、ＰＴＣ抵抗体と電極との接合端面に元素Ａを含まない酸化バナジウム層を有するものとする。

【０００９】そのような限流素子とすれば、元素Ａを含まないV_2O_3層は転移をしないので、熱膨張係数の変化は直線的となり、$(V_{1-x}A_x)_2O_3$系ＰＴＣ抵抗体の転移時の負の膨張の影響が緩和されて、電極接合部近傍での応力が低減され、電極の剥離等を防止することができる。

【００１０】

【発明の実施の形態】次にこの発明の実施の形態を実施例に基づいて説明する。

［実施例１］図１は、本発明の実施例にかかる限流素子の断面図である。図１において、１は限流素子エレメントであり，１ａはＰＴＣ特性を有する例えば組成が$(V_{0.9965}Cr_{0.0035})_2O_3$の$V_2O_3$系ＰＴＣ抵抗体であり，１ｂはＣｒを含有しない$V_2O_3$層である。$V_2O_3$系ＰＴＣ抵抗体１ａの寸法はφ１２×２０ｍｍであり、V_2O_3層１ｂの厚さは１ｍｍである。２はφ１５×５ｍｍのモリブデン（Ｍｏ）電極であり、限流素子エレメント１とはＡｇ－Ｃｕ共晶ろう３でろう付けされている。２は、銅（Ｃｕ）電極でもよい。

【００１１】V_2O_3層１ｂの厚さは０．１～２．５ｍｍの間がよい。なぜならば、０．１ｍｍ未満ではV_2O_3系ＰＴＣ抵抗体１ａの非線形の熱膨張を緩和する緩和層としての効果が十分でなくなり、一方２．５ｍｍより厚くすると、限流素子としてのＰＴＣ特性が低下してしまうからである。この限流素子の製造方法は以下の手順でおこなっている。

（１）V_2O_5またはV_2O_3、Cr_2O_3、Fe_2O_3粉末を、焼成後の組成が$(V_{0.9965}Cr_{0.0035})_2O$

$_3$ ＋Ｆｅ５ｗｔ％およびV_2O_3 ＋Ｆｅ５ｗｔ％となるように配合したものを、それぞれ湿式ボールミルで１２時間混合粉砕して粉末①および②を得る。

（２）上記粉末を金型に粉末②、粉末①、粉末②の順に積層したのち、加圧成形し、その成形体を、水素気流中で１５５０℃で１時間焼成して、限流素子エレメント１を得る。

（３）限流素子エレメント１にＡｇ－Ｃｕ共晶ろう３を介してＭｏ電極２を、真空中で７５０℃×５分間の熱処理によりろう付けし、限流素子とする。

【００１２】このようにして製作した限流素子Ａと、V_2O_3 層を有しない従来の限流素子Ｂでの５００Ａの通電試験結果を表１に、また熱サイクル試験（－５０℃⇔２００℃、２０サイクル）の試験結果を表２に示す。

【００１３】

【表１】

試　料	５００Ａ通電試験による電極の剥離数
本実施例の限流素子Ａ	０個／１０個
従来の限流素子Ｂ	９個／１０個

【００１４】

【表２】

試　料	熱サイクル試験による電極の剥離数
本実施例の限流素子Ａ	０個／１０個
従来の限流素子Ｂ	５個／１０個

表１、２から明らかなように、従来の限流素子Ｂでは、いずれの試験においても半数以上に電極剥離が見られたのに対して、本発明による限流素子Ａでは通電試験、熱サイクル試験のいずれにおいても全く電極の剥離が認められなかった。

【００１５】特に、V_2O_3 系ＰＴＣ抵抗体１ａの端面に形成する層をV_2O_3 系ＰＴＣ抵抗体１ａと基本的に同じ材料のV_2O_3 としたことによって、V_2O_3 系ＰＴＣ抵抗体１ａとの接着強度が強固なものとなった。また、先に述べたように、粉末の調製比を変え、その粉末を層状に積層するだけでよく、焼成等にも余分な工程を必要とせず一度で済むので、製造も容易である。

【００１６】

【発明の効果】以上説明したようにこの発明によれば，$(V_{1-X}\ A_X)_2O_3$ ＰＴＣ抵抗体の端面に、元素Ａを有しないV_2O_3 層を形成することにより、ＰＴＣ抵抗体の転移時の熱膨張係数差による応力が緩和され、通電加熱などによる急激な転移や転移の繰り返しによる電極の剥離を防止して、長期信頼性の著しく向上した限流素子とすることができる。

【図面の簡単な説明】

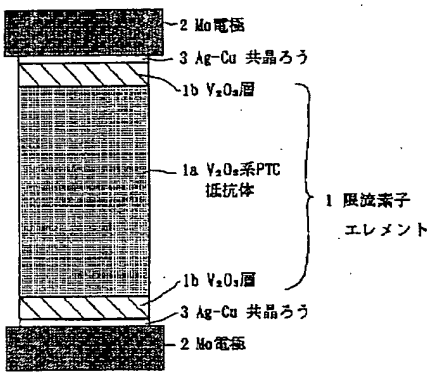
【図１】本発明実施例の限流素子を示す断面図

【図２】V_2O_3 系ＰＴＣ抵抗体の熱膨張係数の温度特性図

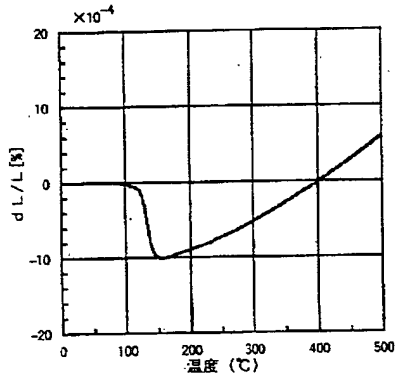
【符号の説明】

１　　限流素子エレメント
１ａ　　V_2O_3 系ＰＴＣ抵抗体
１ｂ　　V_2O_3 層
２　　Ｍｏ電極
３　　Ａｇ－Ｃｕ共晶ろう

【図１】



【図２】



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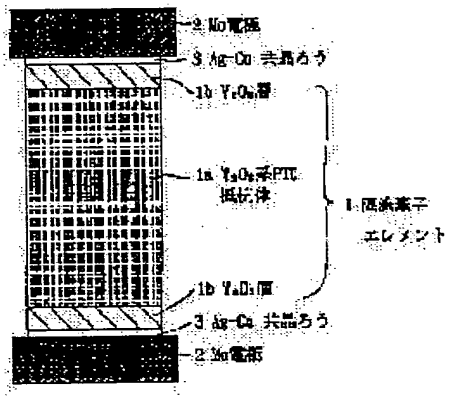
(54) CURRENT-LIMITING ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To avoid exfoliation of electrodes for enhancing the long term reliability of a current-limiting element by forming V2O3 layers having no element A on the end faces of (V1-xAx)2O3 PTC resistor.
SOLUTION: Within a current-limiting element 1, a composition having PTC characteristic is provided with a V2O3 base PTC resistor 1a of (V0.9965Cr0.0035)2O3 and V2O3 layers 1b not containing Cr. Mo electrodes and the current-limiting element 1 are brazed with Ag-Cu eutectic brass 3. Furthermore, the thickness of the V2O3 layers 1b is specified to be 0.1-2.5 mm. This current-limiting element 1 is manufactured by blending V2O5 or V2O3, CrO3, Fe2O3 particles, so that the composition after baking step become (V0.9965Cr0.0035) 2O3 Fe5 wt.% and V2O3 Fe5 wt.% to be mixed and crushed respectively by wet ball mills for producing particles (1) and (2). Next, after laminating the particles (2), (1) and (2) in this order in a metallic mold to be pressure-molded, the Mo electrodes 2 are brazed to the current-limiting element 1 produced by baking in hydrogen current.



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* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Vanadium-oxide system ceramics 2O3 (V1-X AX) [A is a ** style component characterized by having the vanadium-oxide layer which does not contain Element A in the junction end face of a PTC resistor and an electrode in the ** style component using the PTC resistor which are at least one sort of elements chosen from aluminum, chromium, the scandium, or the lanthanoids, consists of 0.001<=x<=0.30], and has a forward resistance temperature characteristic.
[Claim 2] The ** style component according to claim 1 characterized by the thickness of the vanadium-oxide layer which does not contain Element A being in the range of 0.1-2.5mm.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the ** style component which starts the ** style component using a vanadium-oxide system [(V1-X AX) at least 1 sort as which O3 A was chosen from aluminum, chromium, scandium, or lanthanoids of 2 Element] PTC resistor (it is V2 O3 below it abbreviates to a system PTC resistor) with a forward temperature coefficient of resistance, especially is excellent in the dependability over a long period of time.
[0002]
[Description of the Prior Art] In recent years, the overcurrent which flows when large capacity-ization progresses also in a low voltage power distribution system and a load short-circuits in connection with it is also high-current-ized, and high breaking capacity-ization is desired also about the breaker. V2 O3 which uses the vanadium-oxide system ceramics as a principal component as an overcurrent protection component for a high current and large power corresponding to such a technical trend Utilization of the ** style component using a system PTC resistor is expected.
[0003] V2 O3 The system PTC resistor has the property (M-I transition) transferred to an insulating material from a metal among 100 degrees C - 200 degrees C. Near a room temperature, with 10-3 ohm-cm, although specific resistance is small, it is missing from 100 degrees C - 150 degrees C from a room temperature, and it increases gently. It increases rapidly about double figures near 150 degree C (this temperature that increases rapidly is called transition temperature), becomes a peak in 150 degrees C - 200 degrees C, and has the property to fall, at the temperature beyond it.
[0004] V2 O3 which has such a property Temperature rises with the Joule's heat at the time of an overcurrent flowing, and a system PTC resistor can carry out the ** style of the overcurrent according to the resistance buildup using resistance increasing. Therefore, an electrode is joined to this and it is used as a ** style component.
[0005]
[Problem(s) to be Solved by the Invention] V2 O3 As for the PTC phenomenon of a system PTC resistor, specific resistance increases rapidly by change of the band structure at the time of transition. And since an a-axis expands 1.0% to c axis contracting 0.6% with change of this band structure, it is V2 O3. The coefficient of thermal expansion of a system PTC resistor serves as a nonlinear change that negative expansion is shown at the time of M-I transition. The situation is shown in drawing 2 . An axis of ordinate is coefficient of thermal expansion (dL/L), and an axis of abscissa is temperature.
[0006] As an electrode material joined in case it considers as a ** style component, molybdenum, copper, etc. with which the coefficient of thermal expansion is alike are used. However, since it is almost linear, coefficients of thermal expansion differ greatly at the time of transition of a PTC resistor, and the thermal expansion of these metals requires big stress for an electrode plane of composition, and deformation of an electrode and when excessive, it may cause exfoliation of an electrode.
[0007] Made in order that this invention may solve an above-mentioned trouble, the object is V2

O3. It is in easing the stress by the coefficient-of-thermal-expansion difference in the ** style component using a system PTC resistor, preventing exfoliation of an electrode etc., and offering the ** style component which is excellent in dependability over a long period of time.
[0008]
[Means for Solving the Problem] This invention is the vanadium system ceramics (V1-X AX) 2O3 because of the above-mentioned technical-problem solution. [A shall be at least one sort of elements chosen from aluminum, chromium, the scandium, or the lanthanoids, shall consist of 0.001<=x<=0.30], and shall have the vanadium-oxide layer which does not contain Element A in the junction end face of a PTC resistor and an electrode in the ** style component using the PTC resistor which has a forward resistance temperature characteristic.
[0009] V2 O3 which does not contain such a ** style component, then Element A Since it does not transfer, change of a coefficient of thermal expansion becomes linear, and a layer is 2 (V1-X AX)O3. The effect of the negative expansion at the time of transition of a system PTC resistor is eased, the stress near the electrode joint is reduced, and exfoliation of an electrode etc. can be prevented.
[0010]
[Embodiment of the Invention] Next, the gestalt of implementation of this invention is explained based on an example.
[Example 1] drawing 1 is the sectional view of the ** style component concerning the example of this invention. The presentation in which 1 is a ** style component element in drawing 1 , and 1a has a PTC property is 2 (V0.9965Cr0.0035) 03. V2 O3 It is V2 O3 in which it is a system PTC resistor and 1b does not contain Cr. It is a layer. V2 O3 The dimension of system PTC resistor 1a is phi12x20mm, and is V2 O3. The thickness of layer 1b is 1mm. Two is aphi15x5mm molybdenum (Mo) electrode, and is soldered with the Ag-Cu eutectic wax 3 in the ** style component element 1. A copper (Cu) electrode is sufficient as 2.
[0011] V2 O3 As for the thickness of layer 1b, for 0.1-2.5mm is good. Because, at less than 0.1mm, it is V2 O3. It is because the PTC property as a ** style component will fall if the effectiveness as a relaxation layer which eases a nonlinear thermal expansion of system PTC resistor 1a becomes less enough and makes it thicker than 2.5mm on the other hand. The following procedures are performing the manufacture approach of this ** style component.
(1) V2 O5 Or V2 O3, Cr 2O3, and Fe 2O3 Preferential grinding of what blended powder so that the presentation after baking might become 2 (V0.9965Cr0.0035) O3+Fe5wt% and V2 O3+Fe5wt% is carried out with a wet ball mill for 12 hours, respectively, and powder ** and ** are obtained.
(2) Carry out pressing, calcinate the Plastic solid at 1550 degrees C in a hydrogen air current for 1 hour, and obtain the ** style component element 1; after carrying out the laminating of the above-mentioned powder to metal mold at the order of powder **, powder **, and powder **.
(3) Through the Ag-Cu eutectic wax 3, solder the Mo electrode 2 by heat treatment for [750 degree-Cx] 5 minutes in a vacuum in the ** style component element 1, and consider as a ** style component at it.
[0012] Thus, the ** style component A and V2 O3 which were manufactured The energization test result of 500A in the conventional ** style component B which does not have a layer is shown in a table 1, and the test result of a thermal cycling test (-50 degrees C <=> 200 degrees C, 20 cycles) is shown in a table 2.
[0013]
[A table 1]

試　料	５００Ａ通電試験による電極の剥離数
本実施例の限流素子Ａ	０個／１０個
従来の限流素子Ｂ	９個／１０個

[0014]
[A table 2]

試　料	熱サイクル試験による電極の剥離数
本実施例の限流素子A	0個／10個
従来の限流素子B	5個／10個

With the conventional ** style component B, exfoliation of an electrode was not accepted at all in any of an energization trial and a thermal cycling test to electrode exfoliation having been seen also in the trial [which] more than the moiety by the ** style component A by this invention so that clearly from tables 1 and 2.
[0015] especially — V2 O3 the layer formed in the end face of system PTC resistor 1a -- V2 O3 system PTC resistor 1a — fundamental -- V2 O3 of the same ingredient ** — having carried out — V2 O3 The bond strength with system PTC resistor 1a became firm. Moreover, since an excessive process is not needed for baking etc. but it ends with once, manufacture is [that what is necessary is just to change a powdered preparation ratio and to carry out the laminating of the powder to the shape of a layer] also easy, as stated previously.
[0016]
[Effect of the Invention] V2 O3 which does not have Element A in the end face of a 2 (V1-X AX) O3 PTC resistor according to this invention as explained above By forming a layer The stress by the coefficient-of-thermal-expansion difference at the time of transition of a PTC resistor can be eased, exfoliation of the electrode by the repeat of the rapid transition and transition by energization heating etc. can be prevented, and it can consider as the ** style component which dependability is remarkable over a long period of time, and improved.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

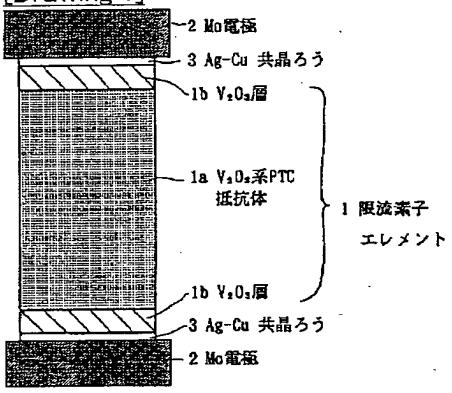
[Brief Description of the Drawings]
[Drawing 1] The sectional view showing the ** style component of this invention example
[Drawing 2] V2 O3 Temperature profile of the coefficient of thermal expansion of a system PTC resistor
[Description of Notations]
1 ** Style Component Element
1a V2 O3 System PTC resistor
1b V2 O3 Layer
2 Mo Electrode
3 Ag-Cu Eutectic Wax

[Translation done.]

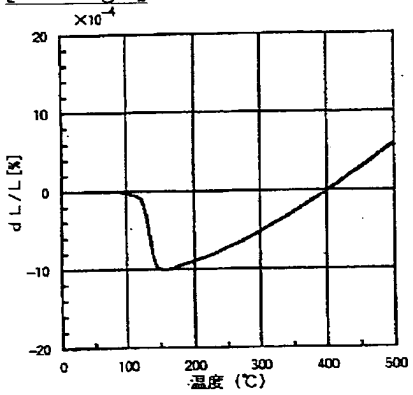
* NOTICES *

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]